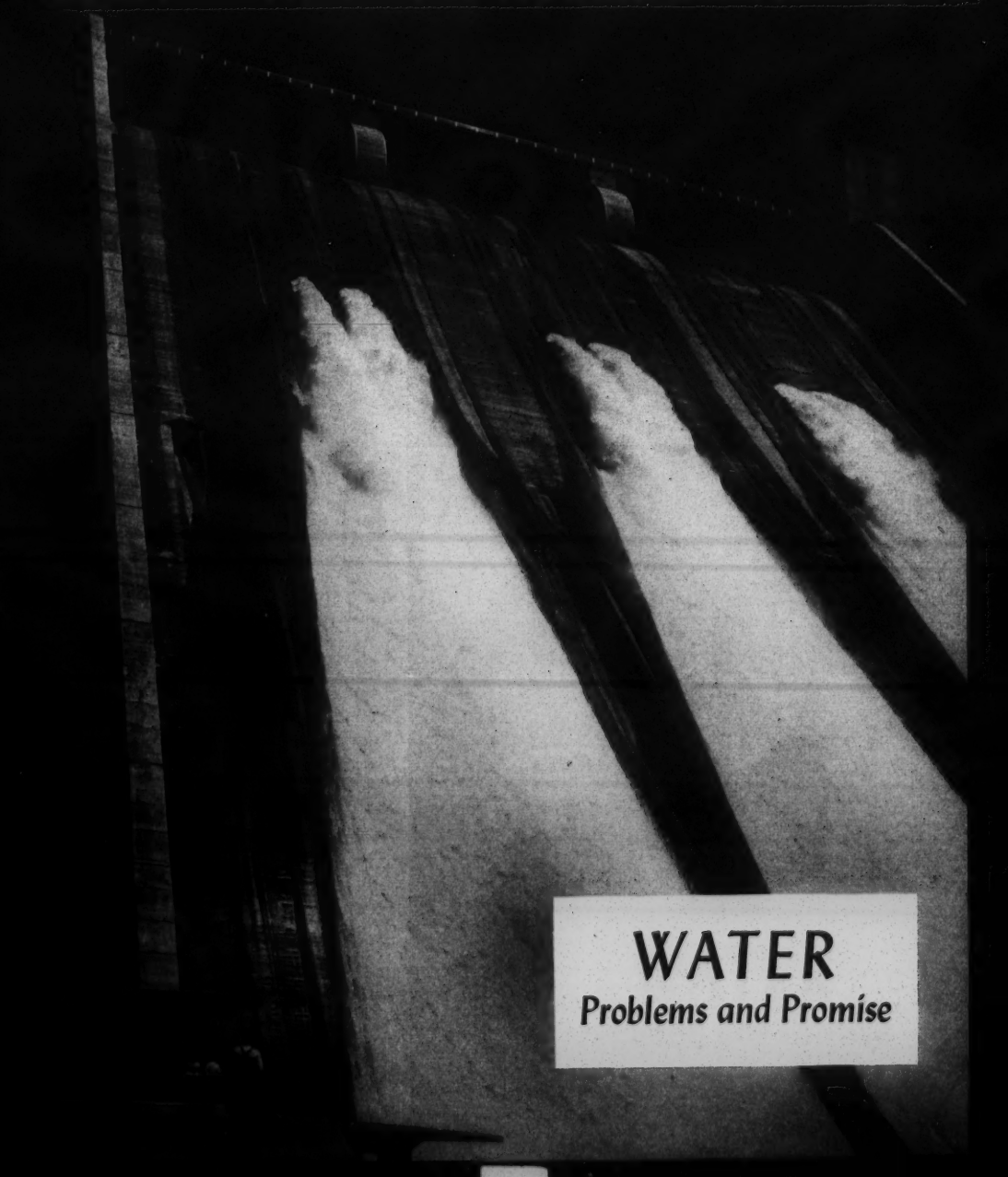
GEOGRAPHIC SCHOOL BULLETINS

THE NATIONAL GEOGRAPHIC SOCIETY, WASHINGTON 6, D. C.

NOVEMBER 23, 1959, VOLUME 38, NUMBER 8 . . . *To Know This World, Its Life*



WATER

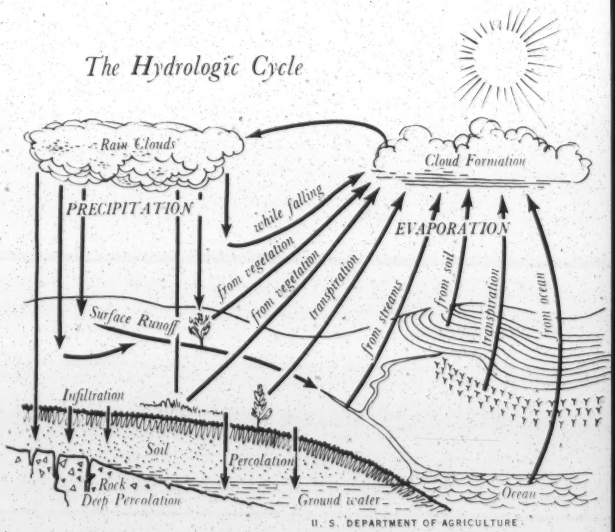
Problems and Promise

is a nonprofit educational and scientific society established for the increase and diffusion of geographic knowledge.

We are still using the same water that we have used since the beginning of time. The sparkling stream from your drinking fountain could well include water that Cleopatra bathed in, or water that was thrown on burning Rome.

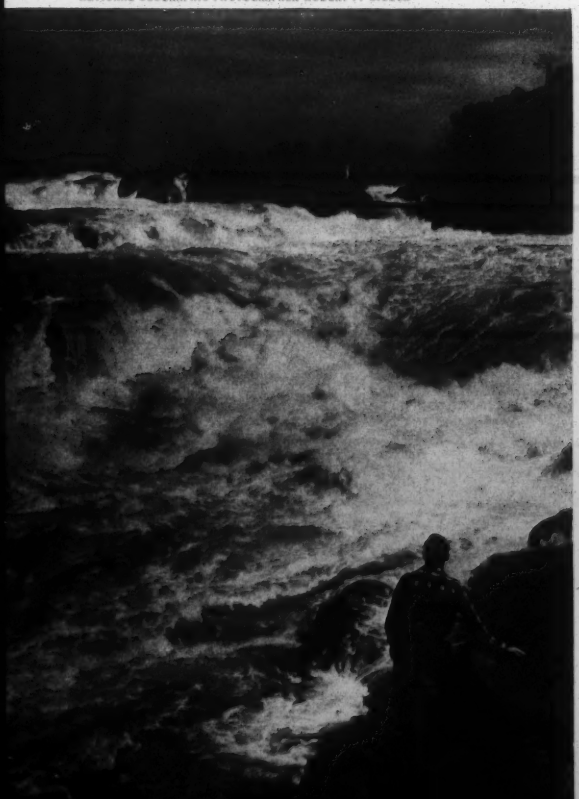
In a sense, the earth is a vast revolving steam engine, powered by the sun (right). Heat evaporates water from the sea and land—turning it into invisible vapor. On cooling, this vapor condenses into droplets that fall as rain, and run back toward the sea (below) if not evaporated or used first.

The Hydrologic Cycle



This endless cycle has been going on since the earth became cool enough to allow condensation. The difficulty is that it doesn't guarantee man the water he wants when and where he wants it. So we imitate parts of this cycle for our own profit. We are learning to take the water from the sea, as the sun does. We build our own rivers and streams, in the form of canals and pipelines. We try to induce rain where we want it by "seeding" clouds.

NATIONAL GEOGRAPHIC PHOTOGRAPHER ROBERT F. SISSON



We stop the seaward rush with dams until we can make use of the water. And every day we want more of it. Our works lag behind our needs—that is the basic problem of water.

As our demands increase, we will have to learn to make better use of our supply—to cleanse our waters more carefully for re-use; to develop new sources and use properly the ones we have.

Water's rush shaped the continents, wearing down the sharp edges of rocks and mountains to form our soil. Now the same force threatens to destroy the soil it made, by washing it into the sea.

Different aspects of the problems associated with water—and the promise of the future—are examined in detail in the articles that follow. F.S.

UMI

Our Wet World

Nothing Can Live Without Water

GLISTENING on plant leaves or splashing from a faucet, water is essential to all life on earth.

Your body is seven-tenths water. Everything you eat used water in the making—as well as almost everything you touch, including this publication.

Life began, we are told, in the sea—and man still carries around inside him his own portion of that ancestral sea. Your blood is salty, at about the same proportion as the sea used to be. (The oceans are saltier now.)

To replenish your own inside sea, you need more than a quart of water each day. A man can live as much as a month without food; lacking water he'll die within a week.

But this vital quart a day is only the beginning of your use of water.

Counting water absorbed by plants and animals to produce your food, and water used by industry to manufacture the thousands of things you use, you require more than 1,000 gallons each day. Water is the largest single raw material used by American factories.

Fortunately, water is virtually indestructible. It is one of the few natural resources that can be used over and over.

U. S. SOIL CONSERVATION SERVICE; COVER, UNITED PRESS

GEOGRAPHIC SCHOOL BULLETINS Copyright © 1959 by the National Geographic Society, Melville Bell Grosvenor, President. Published each week during school months by the School Service Division, Ralph Gray, Chief. Assistants: Arthur P. Miller, Jr., Frank Sartwell, Katherine Crapster, Liva Baker. Entered as second class matter, Washington, D.C. International copyright. All rights reserved. Rates: United States, $2.00 for 30 issues (one school year); Canada, $2.25; elsewhere, $2.50. U. S. only, 3 years (90 issues), $5.00. The National Geographic Society is a nonprofit educational and scientific society established for the increase and diffusion of geographic knowledge.

of water a day—enough to supply a city of 25,000 people.

Outside your city, a farmer washes the vegetables you'll eat tomorrow. A dairy farmer runs water into troughs for the cows to drink. Another farmer digs an irrigation ditch. Multiple billions on billions of gallons of water are needed to produce the food we eat.

Transportation is one of the oldest uses of water. Rivers were the first highways, and are still important routes. Headed Gulfward, towboats on the Mississippi push West Virginia coal and Pittsburgh steel. Riches of the continent's interior ride the St. Lawrence Seaway to the ocean.

The list of uses is endless and still growing as new ways are found to put water to work. But the big thirsty machines of industry outconsume all other demands except irrigation ditches.

Water turned the wheels of our earliest mills. Today it is used not only for power—either as falling water or steam—but for processing, cooling, sanitation, and service purposes such as fire prevention. The paper on which this copy of the *Geographic School Bulletins* is printed required two gallons of water to make (below), not counting the ink or the human sweat that went into it. It takes:

70 gallons to make a pound of woolen cloth; 10 gallons to process a gallon of gasoline; 65,000 gallons to produce a ton of highly finished steel; and 750 gallons to produce a ton of dry cement.

A ton of soap requires the use of 500 gallons of water. Each record played on the phonograph used about 2.5 gallons in its making. When an airplane engine is tested, 50,000 to 125,000 gallons of water are needed for cooling. Around the world there are more and more people—and each uses more and more water.

In the United States, population through the 1950's has increased nearly 2 per cent each year, while water consumption goes up 3.5 to 4 per cent.

One reason is that people concentrate in the cities where they use more water. The larger the city, the higher the water demand per person. People living in towns of 500 may average only 60 gallons apiece a day. City people may average more than 200 gallons.

Another reason for the snowballing demand for water is that every day people are buying more and more goods. Time was when the automobile driver on a country road stopped to help the farmer get his frightened horses past the noisy engine. Today the farmer drives a car and a truck. People buy more. Production accelerates. New products and new processes that drink water are being developed all the time. L.B.

NATIONAL GEOGRAPHIC PHOTOGRAPHER ROBERT F. SISSON

UMI

More! More!

World's Thirst Rising Fast

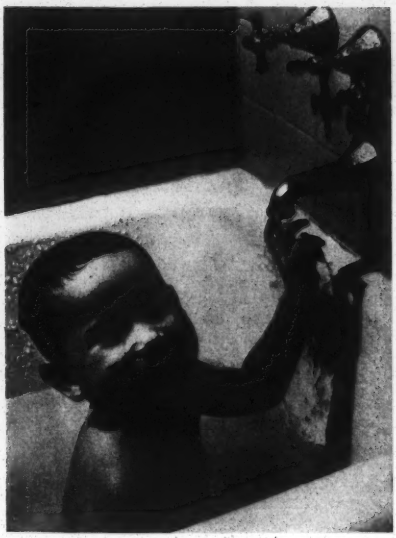
THE PIONEERS carried their day's supply of water in a couple of wooden buckets from a near-by spring to the log cabin.

One might still get along fairly comfortably for 24 hours on one gallon of water for drinking and cooking. But the boy below needs far more. His direct consumption is closer to 200 gallons and going up.

Americans use more than 200,000,000,000 gallons of water a day. The total may increase as much as 70 per cent by 1975.

Each day you need only a few pints of water to replace the moisture thrown off by your body. But this is a mere drop in the

THOMAS AIRVIEWS; BELOW, W. E. GARRETT, NATIONAL GEOGRAPHIC STAFF



bucket. It wouldn't see you through breakfast. A three-minute shower takes 15 gallons. You also brush your teeth and flush the toilet. Your breakfast eggs, bacon, and milk are partly water.

The dishes have to be washed, the lawn sprinkled, and the laundry put in the washer. The more modern the washer, the more water it uses. Sirens scream. Fire engines hitch their hoses to the hydrants, and water gushes out. A street-cleaning truck swishes by, shooting water from curb to curb. You decide to go for a swim in the neighborhood pool.

You catch a streetcar at the corner to go to school or shopping in an air-conditioned store. Thousands of gallons of water are used at the power plant to produce power to move the trolley. To condition the air of a large building may require 3,000,000 gallons

sifts through to become a small stream. As it grows, it becomes a river.

When immigrants rushed to the New World three centuries ago, they found a continent of forest and grassland. What men there were hunted and fished rather than farmed for a living. The spongy floor of the forest covering the eastern half of the continent, and the deep sod of the western prairies were ideally suited to absorbing water, filtering it, and slowly letting it down into streams.

The pioneers plunged headlong into exploitation of the new land. They cleared the forest and furrowed the soil for farms. They overplowed and overgrazed. And the land, its storage facilities destroyed, could no longer hold the water and regulate its flow.

Cities, highways, railroads, airports, mines, and factories further subtracted from the land. Erosion and flooding are the results.

Today erosion robs the nation of the equivalent of 400,000 to 500,000 acres of topsoil every year. A single flood on the rivers in the upper Mississippi Valley cost Iowa, Illinois, and Missouri $153,000,000 in agricultural damage. The storm that caused the flood washed away nearly 5,000,000 tons of precious topsoil.

Above, erosion damaged a wheat farm near Pullman, Washington, when the bare, frozen ground could not absorb the spring rains. Below, the Missouri River floods a farm.

As erosion carries away more and more soil, floods become worse. Streams that once ran clear, cool, and evenly now rage with flash floods at one time and dwindle to a trickle another.

Their water is so loaded with mud that hundreds of millions of tons of it are washed into the sea every year. The Mississippi delta is being built of the farms of 30 States. It is calculated that at flood stage the Missouri River carries past St. Louis the equivalent of two average farms a minute.

This constant loss affects everyone in the country. You may not live along any of the major rivers of the United States, but you drink water, use electricity, and eat roast beef. When sediment clogs the water storage space of a power plant, electricity is lost. Sediment in streams means water must be purified before drinking or other use. And when Corn Belt farms float down the Missouri River, your beef becomes more expensive. L.B.

Water's Brute Strength

WHILE OUR DEMANDS on water spiral to astronomical heights, erosion wastes our supply.

A raindrop—only a tiny part of one of the 4,300,000,000,000 gallons that fall on the country every day—explodes on bare ground. Loosened flecks of soil bounce up in the drop's crownlike splash.

Enough raindrops, allowed to run wild, can strip a farm to a rocky skeleton. Where the countryside is bared, drought inevitably follows as underground streams and reservoirs dry up.

This is erosion. It is slow but enormously powerful. It carved the Grand Canyon, and today carves similar, if smaller, gullies across the country.

Erosion does not create headlines like the torrential spring floods which wipe out homes and families every year as the snow melts and gushes down from the mountains. But basically it works the same way.

The earth cannot absorb the water, so it runs off, carrying along more soil. It destroys croplands, then deposits the silt where it is not welcome. Because of these deposits it is estimated that one out of five American reservoirs will be filled with silt in less than 50 years.

Of the quadrillions of gallons of water that fall on the nation every year, about 70 per cent goes back into the atmosphere by evaporation or by transpiration from plants and animals. The remaining 30 per cent—about 1,300,000,000,000 gallons—collects in rivers, lakes, and the soil. This is what we theoretically have available for our use.

Where the raindrop plops on the carpeted forest floor, the soil retains moisture and stores water. A teeming plant, animal, and insect life creates a porous and crumbly soil ideal for holding, storing, and filtering water. Gradually the water

PHOTOGRAPHS BY U. S. SOIL CONSERVATION SERVICE

WILLARD R. CULVER; BELOW, SPENCE AIR PHOTOS

SHASTA DAM sends water in flumes, above, to turn power plant wheels and wet otherwise dry farms like the canal-patterned California date field below.

Dams like Shasta, with their power plants and affiliated networks of rivers, canals, and irrigation ditches mean more electricity for homes and an even flow of water for sun-drenched fields.

They hold back flood waters, which damage crops and property to the tune of millions of dollars a year, and stockpile the torrents in reservoirs from which they can be drawn in dry seasons. Irrigation is the most demanding of all water consumers, using up more than 100,000,000 gallons a day.

But the full answer to water control and conservation is not in dams. The Chinese have a proverb which goes: "To rule the mountain is to rule the river." Waste begins with erosion in the watersheds of the rivers.

A goal now is to conserve forests, not only to replace a diminishing timber supply, but to conserve water by preventing erosion and floods. L.B.

FURTHER READING ON WATER:

National Geographic—August 1952, "Water for the World's Growing Needs" ($1.00); November 1949, "Sno-Cats Mechanize Oregon Snow Survey" ($1.00); November 1946, "More Water for California's Great Central Valley" ($1.00). *Geographic School Bulletins*—February 3, 1958, "How to Make It Rain" (10¢); February 6, 1956, "Everyday Wonder: Water Supply" (out of print).

UMI

U. S. BUREAU OF RECLAMATION

Taming the Outlaw Torrents

THE TIME IS PAST when Americans can abandon their damaged lands and migrate to virgin country.

We exploited the country for all it was worth with little thought for the future. Now we've got to stop and repair the damage we did. We've also got to learn to live with dry land.

We are not faced with drought, nor are we running out of water—yet. We still consume only about one gallon out of each six or seven allotted by nature. The problem is that our water is not evenly distributed. If it were, every acre would get 30 inches of precipitation a year. As it is, one area, such as the Washington coast west of the Olympic Mountains, may get 100 inches a year, while another region in the same State may get only 10 inches.

We are neither the first nor the last to have to control water. One can imagine a very early man laying a line of stones across a brook to guide the water over a garden planted near by. The Romans solved their water problems by piping 130,000,000 gallons of water a day to their capital through aqueducts up to 60 miles long. Southeast 1,500 miles, in what is now the Negev desert, Nabataean technicians built dams to provide a year's supply of water for people and crops from the few inches of rain that fell in the spring.

Today a world-wide boom in dam building is changing the face of continents and helping man fight his eternal battle for water. Water flows on the dusty plains of India which once waited thirstily for monsoon rains. Electric light penetrates the long nights of far Siberia. Africa's raging Zambezi River has been tamed.

Dams mark a beginning of the control and conservation of water. The Shasta Dam, above, third highest in the United States, changed the nature and look of California.

Before it was built, the orchards of the southern San Joaquin Valley were dying and man left the land. In the Sacramento Valley, farther north, floods swept over the fertile fields and drowned homes. The dam allows water from the north, where there was too much, to be moved south, where there was not enough.

NATIONAL GEOGRAPHIC PHOTOGRAPHER JOSEPH BAYLOR ROBERTS

Man's Last Water Hole, the Ocean

LOOKING AT THE EARTH as a whole, there is certainly no shortage of water. Oceans cover almost three-quarters of its surface. The trouble is that the ocean is laden with minerals—chiefly salts—that flowing water has washed out of the land.

For centuries, men have dreamed of what could be done with desalted ocean water. It could be spread on the deserts—and the deserts would flower richly. It could guarantee farms against drought, and cities against thirst. It could, in short, solve the water problem. There are indications now that it will.

Actually, it is not too hard to brew sparkling fresh water from the sea. The problem is expense. A gallon of distilled sea water costs many times more than one of ordinary city water. Scientists around the world are at work constantly to bring down the costs. As they succeed in lowering them, little by little, processed water comes closer and closer to being competitive.

Twenty years ago, the price tag on 1,000 gallons of distilled water was about $5. In existing plants the cost runs from about $1.75 to $2.80—still too high to compete with present city water costs of approximately 30 cents per 1,000 gallons.

Five pilot plants are planned in the United States to test promising methods of conversion. The first will be built on the Gulf Coast; others will face the Atlantic and Pacific. Two will be erected inland to convert brackish water—water less salty than the ocean. Other experiments are underway in many countries.

Many persons already live on converted sea water. In places where costs are not the chief consideration, huge plants boil ocean water, extract the mineral-free steam, and cool it for use. Oil-rich, water-poor Kuwait has large installations. Bahrain, also on the Persian Gulf; Tobruk in Libya; Aruba in the Netherlands Antilles; and the Orange Free State in Africa drink desalted water.

Distillation, either by heat, atomic power, or solar energy, seems to be the best process for converting ocean water. Brackish water might be treated by electrodialysis—removal of salt by attracting its ions through membranes by electricity. Other methods in experiment include freezing and thawing processes.

Another possible source of water is under investigation. Scientists are elbowing the poets aside to study the dew (picture, page 86). Especially in Israel and California, dew deposited on plants is a major factor in their growth. F.S.

UMI

TWO SEWERS: A four-foot pipe sends raw sewage into historic Brandywine Creek at Wilmington, Delaware, converting the stream itself into an open sewer. This sorry scene is repeated in thousands of places across the country.

PHOTOGRAPHS BY U. S. DEPARTMENT OF AGRICULTURE

A Losing Battle Against Filth

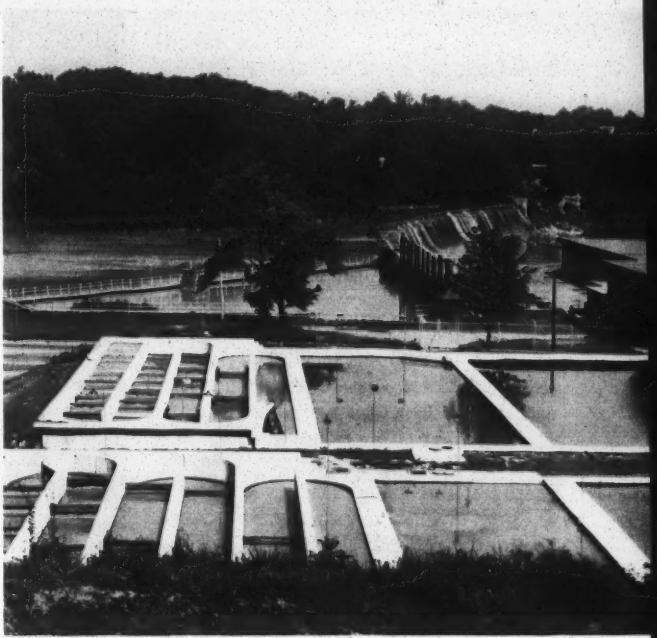
EVERY BIRD knows better than to foul its own nest. It is a lesson man hasn't quite learned.

Far too often, he takes life-giving water from the rivers and returns death-dealing pollution. It happens in the highly developed United States; it happens in the least modern countries of Asia. Man sets about poisoning himself.

There are three basic types of pollution. In America the largest part is chemicals left over from manufacturing.

The second is human sewage, such as that befouling a stream in the picture above. The third is silt—soil washed from the farm lands where it is invaluable into streams where it fills up reservoirs and blankets water life with choking muck.

We know how to combat each of these. Silt would stay on the hillsides if proper farming and lumbering methods were used. Human sewage can be treated, and clean liquid returned to the stream. Manufacturers can be forced by law or public opinion to clean up the stuff they throw into the rivers. The plant at right, at Schoolfield, Virginia, cleans waste from the Dan River Mills before returning its water to the river for use downstream.



Although we know how to do all these things, we are currently not gaining in the battle. Pollution generated by growing population and industrialization is increasing at a faster rate than treatment facilities. F.S.

HUGH ACKROYD

Rain Makers Deliver a Drenching Storm on Schedule

SNOW CLOUDS dump hundreds of tons of water on fields near Gresham, Oregon. It may sink into the earth to become part of our underground water supply. It may be drawn up through plant roots to bring them their ration of food from the soil. It may trickle over the land, forming creeks and rivers to flow into the sea. In the end it will be drawn up again into the air to soak a field somewhere else. Seeders produced this storm by dropping pellets of dry ice into the cloud.

UMI